

Physics education research: Resources for middle school science teachers

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*Treat people as if they were what they ought to be and you help them
to become what they are capable of being.*

Johann Wolfgang von Goethe

Education is not the filling of a bucket, but the lighting of a fire.

W. B. Yeats

Pick battles big enough to matter, small enough to win.

Jonathan Kozol

Abstract

This resource letter intends to provide middle school science teachers with a collection of resources to aid them in planning and implementing a physical science curriculum. The resources are in the form of books, websites, journals, and organizations.

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1 Books

1.1 General Education Research

Educational research is a rapidly expanding field, with new findings emerging in such varied areas as neuroscience, cognitive science, and educational technologies. For those with an interest in current developments in educational research and how these may apply to your instruction, two books discussing these research findings are presented here.

- National Research Council, *How People Learn: Brain, Mind, Experience, and School* (National Academies Press, Washington D. C., 2000)

<http://www.nap.edu/books/0309070368/html/>

This book, the result of work by two committees of the Commission on Behavioral and Social Sciences and Education of the National Research Council, describes our current understanding of mind, brain, and the process of learning, and summarizes effective curricula based on these research areas in areas ranging from history to physics.

- D. Rose and A. Meyer, *Teaching Every Student in the Digital Age: Universal Design for Learning* (Association for Supervision & Curriculum Development, Alexandria, 2002)

<http://www.cast.org/teachingeverystudent/ideas/tes/>

Initially intended as a curriculum for students with special learning needs, Universal Design for Learning (UDL) has transformed the way educators think about learning for all students. The first part of this book presents the case for UDL by describing neuroscientific evidence for learner differences and how insights about special-needs students can inform more effective curricula. The second part describes the practical applications of UDL in the classroom, particularly in the form of educational technologies.

1.2 Physics and Science Education

Many books provide teachers at the elementary and middle school levels with both science content and educational applications in the physical sciences.

- P. E. Blosser, *How to... Ask the Right Questions* (NSTA Press, Arlington, 1991)
Asking questions is a fundamental and essential part of science instruction; this booklet offers guidance in how to analyze and improve questioning techniques.
- N. Herr, *The Sourcebook for Teaching Science: Strategies, Activities, and Instructional Resources*

Herr's sourcebook is an incredible resource for middle and high school science teachers. The book offers scientific content for teachers, activities and experiments, lesson plans, and strategies for adapting scientific material to diverse student populations.

- P. Hewitt, *Conceptual Physics* (Addison Wesley, Upper Saddle River, 2008)

Hewitt's *Conceptual Physics* is used as a textbook in many high school physics courses. It is a conceptual approach to physics that makes few mathematical demands of the reader. As such, it can be of value to elementary and middle school teachers who seek a deeper understanding of the physics topics they are teaching.

<http://www.conceptualphysics.com/>

- P. Keeley, F. Eberle, and J. Tugel, *Uncovering Student Ideas in Science, Vols. 1 and 2* (NSTA Press, Arlington, 2005 and 2007)

This two-volume series provides formative assessment probes designed to evaluate your K-12 students' preconceptions in the Physical, Life, and Earth Sciences.

- National Geographic Reading Expeditions

"Reading Expeditions content-area readers offer students a rich array of engaging and thought-provoking science and social studies content while developing nonfiction literacy skills and strategies. Throughout the books, students are exposed to nonfiction text features, graphic elements, organizational patterns and nonfiction genres. Attention to the intricacies of nonfiction provides students with the tools for reading and comprehending informational text." (From the website.)

<http://www.ngsp.com/Products/ReadingLanguageArts/nbspnbspnReadingExpeditions/tabid/112/Default.aspx>

- National Science Teachers Association Publications

The National Science Teachers Association publishes a large number of books on general and specific topics in science education at all grade levels.

<http://www.nsta.org/store/?lid=tnavhp>

- *Stop Faking It! Finally Understanding Science So You Can Teach It* Series

This series, published by the NSTA, provides invaluable science content to teachers who need to learn or review various topics in the physical sciences. Topics include Energy, Force and Motion, Sound, Electricity and Magnetism, Light, Math, and Chemistry Basics.

<http://www.nsta.org/store/search.aspx?action=quicksearch&text=%22stop+faking+it!%22&gl=0&sid=0>

1.3 Physics Activities and Demonstrations

A wide range of physics activities and demonstrations for K-12 science classes are offered in the following books.

- J. Cunningham and N. Herr, *Hands-On Physics Activities with Real-Life Applications* (Jossey-Bass, Hoboken, 1994)
- R. Ehrlich, *Turning the World Inside Out and 174 Other Simple Physics Demonstrations* (Princeton University Press, Princeton, 1990)
- S. Smith, *Project Earth Science: Astronomy* (NSTA Press, Arlington, 2001)
- J. C. Sprott, *Physics Demonstrations: A Sourcebook for Teachers of Physics*, (University of Wisconsin Press, Madison, 2006)
- P. Walker and E. Wood, *Hands-On General Science Activities with Real-Life Applications* (The Center for Applied Research in Education, West Nyack, 1994)
- B. Yeany, *If You Build It, They Will Learn: 17 Devices for Demonstrating Physical Science* (NSTA Press, Arlington, 2006)

2 Journals

A number of journals publish articles on various issues related to elementary and middle school science education. Although membership is required for full access to most of these journals, many of their articles are available for free online. Membership in NSTA comes with a subscription to one of its journals.

- Science and Children

Published by the NSTA, this journal focuses on elementary school science education.

<http://www.nsta.org/elementaryschool/>

- Science Scope

Published by the NSTA, this journal focuses on middle school and junior high school science education.

<http://www.nsta.org/middleschool/>

- The Physics Teacher

Published by the American Association of Physics Teachers, this journal focuses primarily on physics education at the high school and college level, however, it can also be useful for earlier education.

<http://scitation.aip.org/tpt/>

- Science in School

A new European journal dealing with various issues in elementary, middle, and high school science education.

<http://www.scienceinschool.org/>

- Science World

“Science World for grades 6–10 brings science to life with fascinating feature articles and hands-on activities that cover every area of the science curriculum: physical science, life science/health, earth and space science, environmental science, and technology.” (From the website.)

<http://teacher.scholastic.com/products/classmags/scienceworld.htm>

3 Organizations

Two organizations provide useful resources for physics instructors:

- American Association of Physics Teachers (AAPT)

<http://www.aapt.org/>

The AAPT — which is in the process of changing its name to the Association for the Advancement of Physics Teaching to better represent its mission — places a large emphasis on professional development in the form of workshops and conferences, which makes its website less useful for specific teaching advice. However, it’s worth checking out once in a while if only for its monthly AAPT News (<http://www.aapt.org/aboutaapt/news.cfm>). More importantly, the AAPT maintains comPADRE: Resources for Physics and Astronomy Education, which contains a vast number of resources for physics instructors (<http://www.compadre.org/>).

- National Science Teachers Association (NSTA)

<http://www.nsta.org/>

The NSTA website provides ample resources for science instructors. The main page contains a frequently-updated collection of recent news in science education. The most impressive gem of the NSTA website, however, is the newly released NSTA Learning Center (<http://learningcenter.nsta.org/>), which contains a large collection of well-organized resources on everything from theories of learning to concept-specific activities. You may want to consider becoming a member, which provides you with full access to the online resources as well as a subscription to an NSTA journal publication of your choice. Take a look in the Science Store for an impressive and extremely useful collection of publications.

4 Websites

There is an overwhelming collection of websites that offer lesson plans, on- and offline activities, science content materials, and much more. What follows is a sample of websites with useful and easily accessible resources.

4.1 Activities and lesson plans

- At Home Astronomy
<http://cse.ssl.berkeley.edu/AtHomeAstronomy/>
- The Discovery Channel Lesson Plan Library
<http://school.discoveryeducation.com/lessonplans/>
- edHelper.com
<http://edhelper.com/>
- Exploratorium
<http://www.exploratorium.edu/>
- Howard Hughes Medical Center: Cool Science
<http://www.hhmi.org/coolscience/resources/SPT-Home.php>
- HubbleSite—Education and Museums
http://hubblesite.org/education_and_museums/
- Inside Einstein’s Universe
<http://www.cfa.harvard.edu/seuforum/einstein/>
- International Year of Astronomy 2009
<http://www.astronomy2009.org/>
- Internet for Classrooms
http://www.internet4classrooms.com/skills_7th_science.htm
- The Lesson Plans Page
<http://www.lessonplanspage.com/ScienceJH.htm>
- Lesson Plan Search
http://www.lessonplansearch.com/Science/Middle_School_6-8/Physical_Science/index.html
- Little Shop of Physics
<http://littleshop.physics.colostate.edu/onlineexperiments.htm>

- Middle School Science
<http://www.middleschoolscience.com/>
- Museum of Science and Industry Chicago: Educator Resources
<http://www.msichicago.org/education/educator-resources/>
- My Schoolhouse
<http://www.myschoolhouse.com/courses/Science-Lessons.htm>
- NASA Educators
<http://www.nasa.gov/audience/foreducators/index.html>
- NASA's Imagine the Universe
<http://imagine.gsfc.nasa.gov/index.html>
- NASA Mars Exploration Rover Mission: Classroom
<http://marsrover.nasa.gov/classroom/>
- National Energy Education Development Project
<http://www.need.org/curriculum.php>
- PBS NOVA Teacher's Guide: Physics
http://www.pbs.org/wgbh/nova/teachers/resources/subj_10_00.html
- School Physics
<http://www.schoolphysics.co.uk/index.php>
- Science and Mathematics Initiative for Learning Enhancement (SMILE): Physics
<http://www.iit.edu/~smile/physinde.html>
- Science Buddies
<http://sciencebuddies.org/>
- Science Central Middle School Lesson Plans
<http://www.sciencecentral.com/site/488985>
- Science Lesson Plans
<http://www.col-ed.org/cur/science.html>
- Science Smarties
<http://teachnet.ie/mamond/2006/>
- The Science Spot Astronomy Lesson Plans
<http://sciencespot.net/Pages/classastrolsn.html>

- SDSS Galaxy Zoo
<http://www.galaxyzoo.org/>
- Teachnology Physics Lesson Plans
http://www.teach-nology.com/teachers/lesson_plans/science/physics/
- Try Science
<http://www.tryscience.org/>
- WMAP Education Resources
<http://map.gsfc.nasa.gov/resources/edresources1.html>

4.2 For Kids

- Cool Science at the Howard Hughes Medical Center
<http://www.hhmi.org/coolscience/forkids/>
- Jefferson Lab: Student Zone
<http://education.jlab.org/indexpages/index.php>
- Kids.gov Physical Science
http://www.kids.gov/6_8/6_8_science_physics.shtml
- Learner.com Amusement Park Physics
<http://www.learner.org/interactives/parkphysics/>
- NASA Kids' Club
<http://www.nasa.gov/audience/forkids/kidsclub/flash/index.html>
- NASA Students
<http://www.nasa.gov/audience/forstudents/index.html>
- Optical Research Associates: Optics for Kids
http://www.opticalres.com/kidoptx_f.html
- PBS NOVA Special Effects: Monsters, Motion, and Mechanics
<http://www.pbs.org/wgbh/nova/specialfx/fxguide/fxuemmm.html>
- Simply Science Physical Science Links for Kids
<http://www.simplyscience.com/physicalslinks.html>

4.3 General content

- Cosmic Journey: A History of Scientific Cosmology
<http://www.aip.org/history/cosmology/>
- Eric Weisstein's World of Science
<http://scienceworld.wolfram.com/>
- NSTA Learning Center
<http://learningcenter.nsta.org/>
- Open Culture: Free Online Courses
<http://www.oculture.com/2007/07/freeonlinecourses.html>
- The Particle Adventure
<http://particleadventure.org/index.html>
- Physics Central: Learn How Your World Works
<http://www.physicscentral.com/>
- The Physics Classroom: A High School Physics Tutorial
<http://www.physicsclassroom.com/Class/index.cfm>
- Physics To Go
<http://www.compadre.org/informal/index.cfm>

4.4 Science Education Standards

- Illinois State Board of Education: Science Learning Standards
<http://www.isbe.state.il.us/ils/science/capd.htm>
- National Science Education Standards (Chapter 6)
http://www.nap.edu/openbook.php?record_id=4962

4.5 Videos and Animations

- BrainPOP
<http://www.brainpop.com/>
- Clint Sprott's The Wonders of Physics
<http://sprott.physics.wisc.edu/wop.htm>
- Interactive Simulations
<http://phet.colorado.edu/simulations/index.php?cat=Physics>

- Interactive Shockwave Physics Modules
<http://ippex.pppl.gov/interactive/>
- Physics Simulations Collection
<http://apphysicsb.homestead.com/vls.html>
- Planet SciCast
<http://www.planet-scast.com/films.cfm>
- A Private Universe
<http://www.learner.org/resources/series28.html>

5 iTunes

iTunes is becoming a vast resource for educators of science, now containing a huge number of podcasts (both audio and video) with science content. To get started, take a look at the following (you may access these by going to iTunesU → Teaching & Education → Curriculum & Teaching):

- iTunesU → WGBH → Grades K-5 — Educator Guides
- iTunesU → WGBH → Grades 6-8 — Educator Guides
- iTunesU → WGBH → Earth and Space Science
- iTunesU → WGBH → Physical Science

6 Miscellaneous

- comPADRE: Digital Resources for Physics Education
<http://www.compadre.org/portal/index.cfm>
- Helping Students Learn Physics Better
An article that outlines major preconceptions held by students in physics classes.
<http://phys.udallas.edu/C3P/Preconceptions.pdf>
- Museum of Science and Industry Chicago: Teacher Workshops
All participants in these workshops receive the following: 5 free teacher workshops with paid subs for the days you miss from school, a unit of lesson plans for each of the five workshops with a large rubbermaid container full of all of the materials needed to teach the lessons, one free learning lab at the museum for your class during that school year, and paid buses for your class to come to the museum on that day.
<http://www.msichicago.org/education/educator-resources/teacher-workshops/>

- Mythbusters on the Discovery Channel
 “It’s a tough job separating truth from urban legend, but the MythBusters are here to serve. Each week special-effects experts Adam Savage and Jamie Hyneman take on three myths and use modern-day science to show you what’s real and what’s fiction.” (From the website.)
<http://dsc.discovery.com/fansites/mythbusters/mythbusters.html>
- National Energy Education Development Project: Teacher Training
<http://www.need.org/training.php>
- Science Class e-mail Newsletter
 “*Science Class* is a monthly e-mail newsletter that delivers theme-based content to teachers every month in elementary, middle level, and high school editions. News articles, SciLinks, journal articles from the NSTA archives, and appropriate books support each theme.” (From the website.)
<http://www.nsta.org/publications/archive-scienceclass.aspx>
- Study Island
<http://www.studyisland.com/>
- Time Warp on the Discovery Channel
 “Using the latest in high-speed photography, the Time Warp team takes some natural events (a cat licking its paw, a champagne bottle being opened)—and some not-so-natural (a water balloon to the face, a raw piece of chicken exploding)—and turns them into a thing of both beauty and learning.” (From the website.)
<http://dsc.discovery.com/tv/time-warp/time-warp.html>